AD-A066 764 NAVY UNDERWATER SOUND REFERENCE LAB ORLANDO FLA F/G 17/1
AN/SQS-4 TRANSDUCER MOD 3.(U)
DEC 61

UNCLASSIFIED USRL-CALIBRATION-1803 NL

1 OF 1
ADA
066764

END
DATE
FILMED
5 79
DDC

Department of the Navy, Office of Naval Research
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 8337, Orlando, Florida

MC/asl
RP-2280
7 Dec 1961

CONFIDENTIAL

CALIBRATION REPORT No. 1803

Subj: AN/SQS-4 transducer Mod 3; calibration of

Ref: (a) USRL Research Report No. 55, "Transducer Calibration from Near-field Data," by W. J. Trott

Encl: (1) Drawings USRL 26213 through 26225 and 20113
(2) Table 1

1. This calibration was accomplished as a further extension of the near-field measurement technique reported in reference (a).

2. Reference (a) provides the theory and equations as well as the method for obtaining transducer calibrations from near-field data. In this report the AN/SQS-4 transducer was treated as a line transducer when used as an omni-search transducer, but when used with the scanning switch for measuring rotating directivity receiving (RDR) the AN/SQS-4 transducer was treated as a piston.

3. Near-field measurements were made using the type LC32 transducer and the USRL type F31 line transducer. The type LC32 transducer was used as a probe that was moved parallel to the Z axis of the AN/SQS-4 transducer to produce the data for computing far-field omni-search patterns and the transmitting current response (omni). The data show that a cylindrical wave exists beyond a distance of 2 diameters from the center of the AN/SQS-4 transducer; this restriction is due to the large diameter of the AN/SQS-4 transducer. Theory predicted the distance a, such that $3 < ka < 2\pi(L/\lambda)^2$ for a very thin line. In the case of the AN/SQS-4, $a > 3\lambda/2\pi = 3.2$ inches. Data show that if the line has the radius $r_0 > \lambda$, then $4r_0 < a < L^2/\lambda$. The type F31 line transducer consists of 18 individual elements approximately 2 inches in diameter and 2 inches long. The over-all length of the transducer is 38 inches. This transducer was used to measure the RDR data in both vertical and horizontal sweeps (along the Z and Y axis). Drawing USRL 26213 of enclosure (1) is the XZ-plane directivity pattern (near and far field) of the type F31 line transducer. The individual element sensitivities are shown on Drawing USRL 26214 of enclosure (1). Drawing USRL 26215 shows the XY-plane directivity pattern of the F31 line transducer and indicates that the F31 does not act as a thin-line transducer and probably accounts for the variation in the computed patterns and sensitivities; that is, the two active faces of each line element (2 inches in diameter and 2 inches apart) do not measure at a point, but measure some average value of amplitude and phase. The 270-degree face of the elements was used as the 0-degree face of the line.

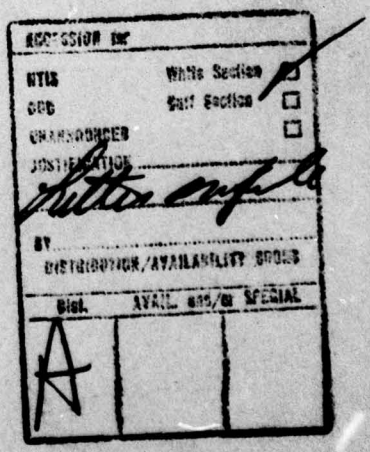
4. Near-field measurements were made to obtain data for computing the following: transmitting current response (omni), omni-directivity patterns in the XZ plane, free-field voltage sensitivity (RDR), and directivity patterns (RDR) in the XY and XZ planes. The free-field voltage sensitivities (RDR) were computed for distances 66, 50, 38, 75, 50, 44, and 56 inches. The free-field voltage sensitivities are shown in Table 1, enclosure (2). The directivity patterns are shown on Drawings USRL 26216 through 26222, enclosure (1). The transmitting current responses (omni) were computed for 9 different distances and corrected to one meter. These data are shown in Table 1. The directivity patterns (both near-field and far-field) for two distances are shown on Drawings USRL 26223 and 26224, enclosure (1). Drawing USRL 26225 shows values of free-field voltage sensitivities of the AN/SQS-4 (from near-field data) for the distance range 37 to 200 inches; this drawing shows the effective range in which near-field measurements may be made on the AN/SQS-4 transducer using the cylindrical wave. The S. A. CAF-4 computer is limited to computing ±60 degrees of pattern; however, this limit is believed to be adequate for most measurements.

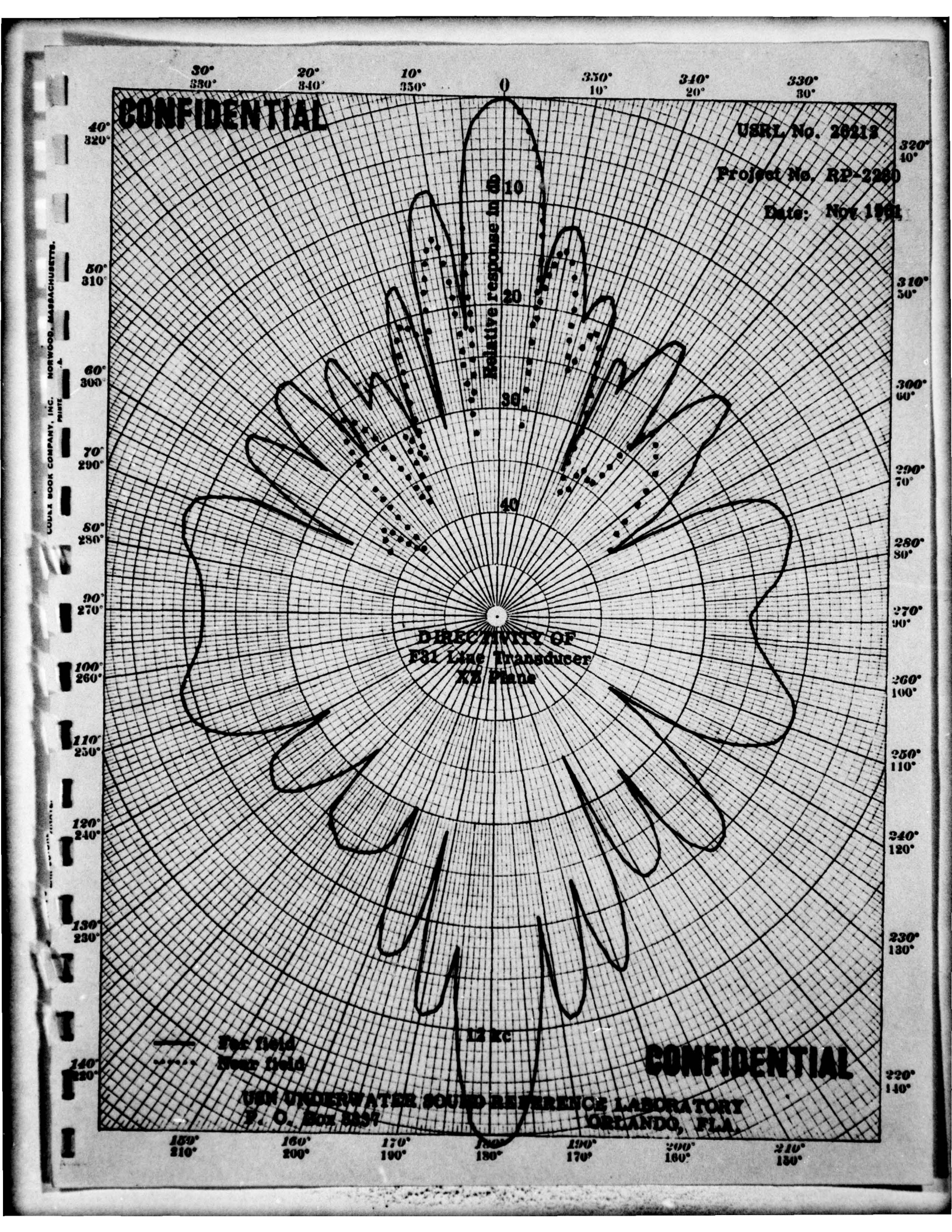
5. Orientations were according to the method described in Drawing USRL 20113, enclosure (1), for a cylindrical transducer with the center of the cylinder as the zero reference in the XZ plane.

Marshall Cartledge

MARSHALL CARTLEDGE
Data Analyst

Copy to:
ONR (101)(1)
ONR (102)(1)
ONR (108)(1)
ONR (411)(1)
ONR (466)(1)
ONR (LCDR J. C. Bajus)(1)
BUSHIPS (688)(1)
BUSHIPS (370)(1)
USRL (210)(1)




CONFIDENTIAL
USRL No. 26213
Project No. RP-2280
Date: Nov 1961
Relative response in db
0
10
20
30
40
DIRECTIVITY OF
F31 Line Transducer
XZ Plane
12 Kc
Far field
Near field
CONFIDENTIAL
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 8337
ORLANDO, FLA.
COLONIAL BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.
PRINTED IN U.S.A.

CONFIDENTIAL

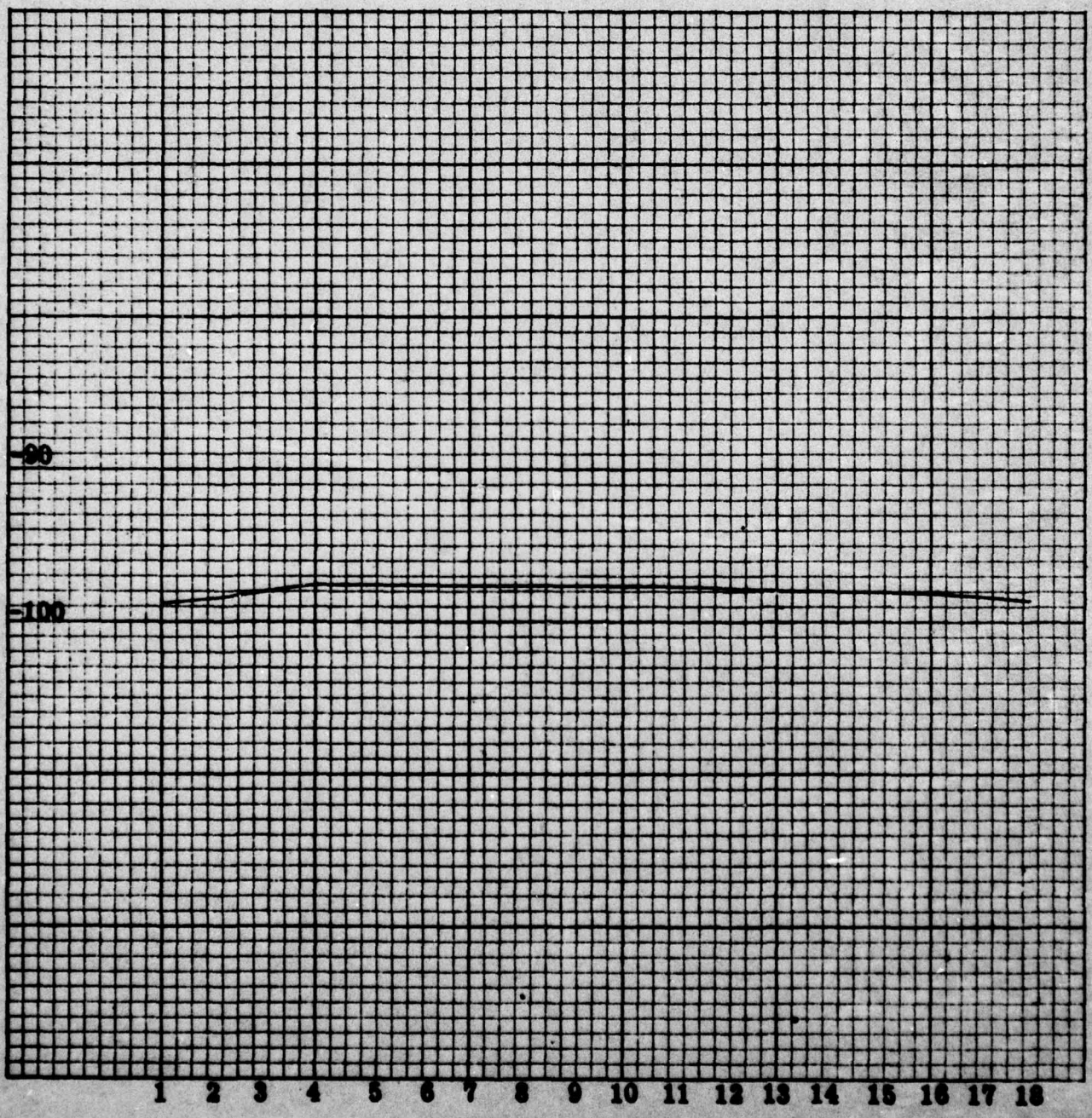
Department of the Navy, Office of Naval Research
UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 8337, Orlando, Florida

USRL No. 26214
Proj. No. RP-2280
Date: Nov 1961

FREE-FIELD VOLTAGE SENSITIVITY
F31 18-Element Line Transducer
Individual element sensitivity at 12.0 kc

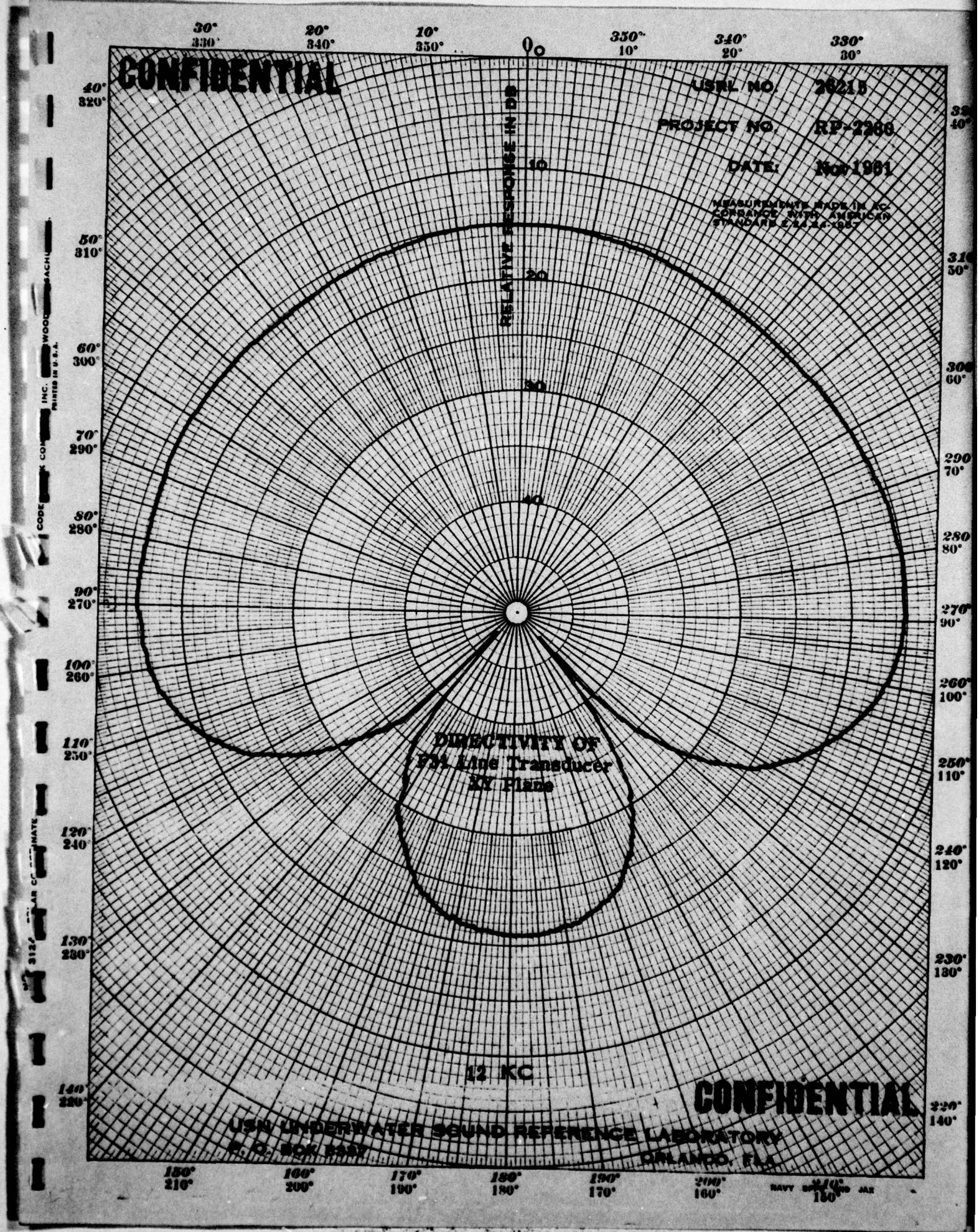
Water temp: °C

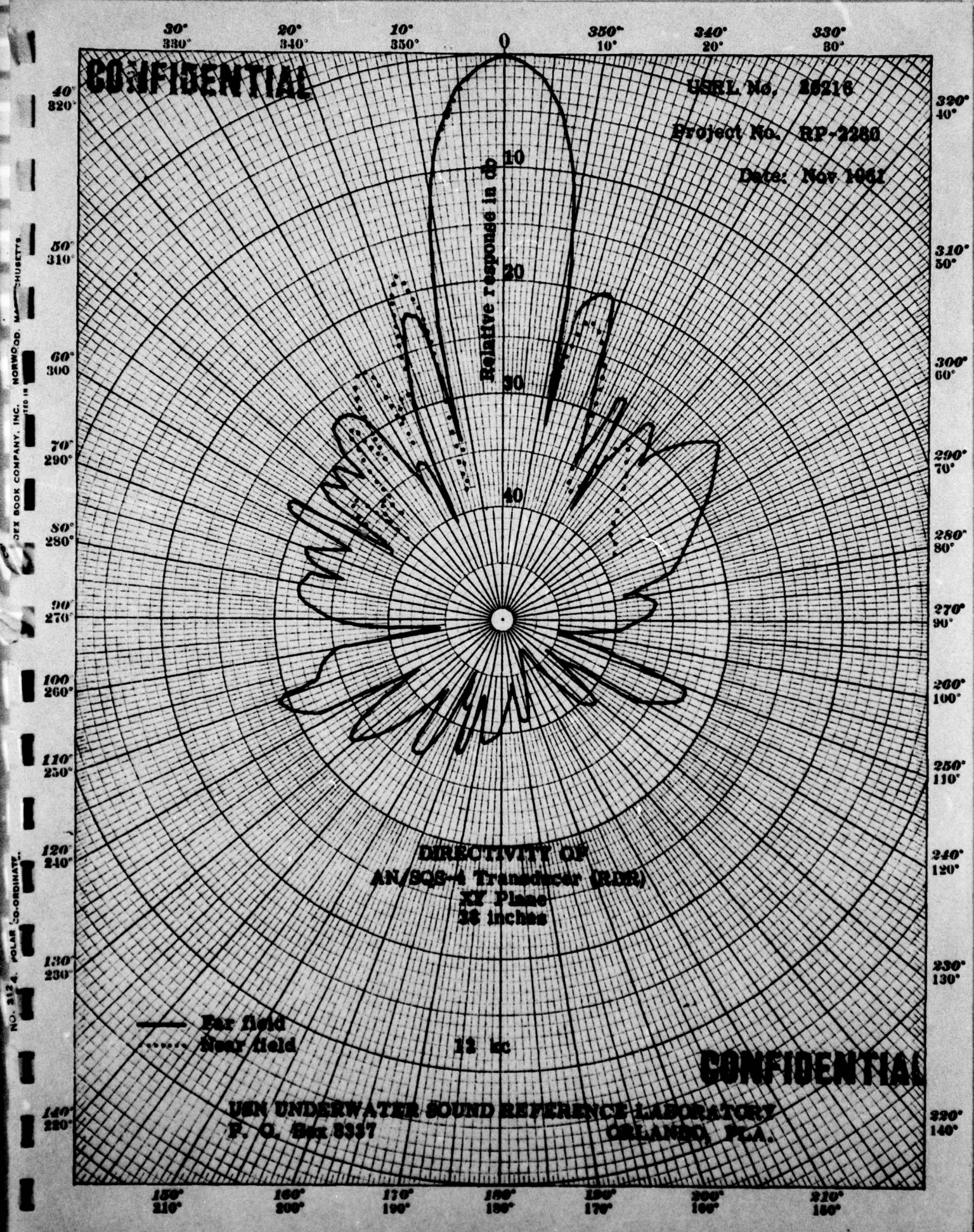
MEASUREMENTS MADE IN ACCORDANCE WITH AMERICAN STANDARD Z.24.24-1957

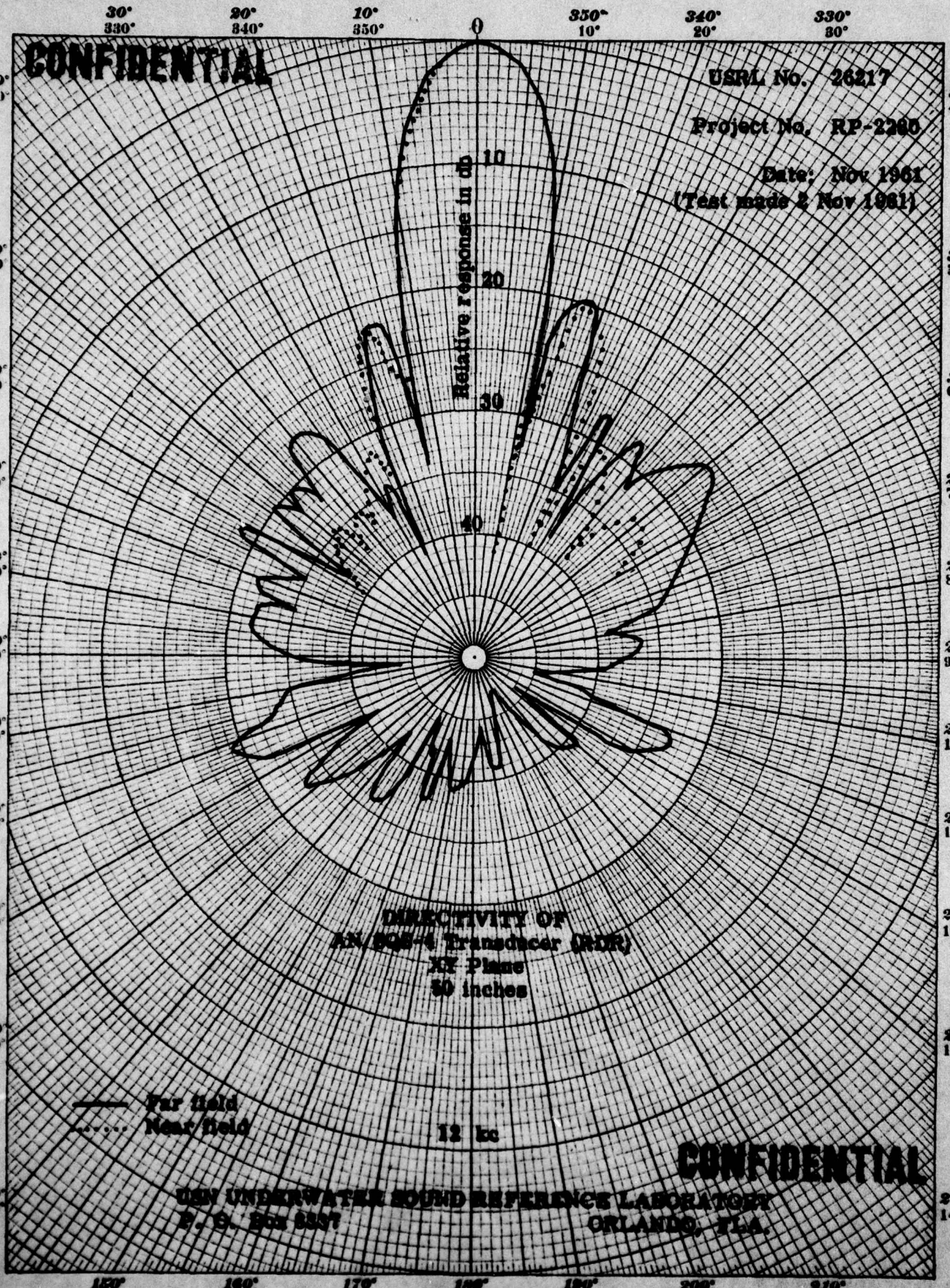


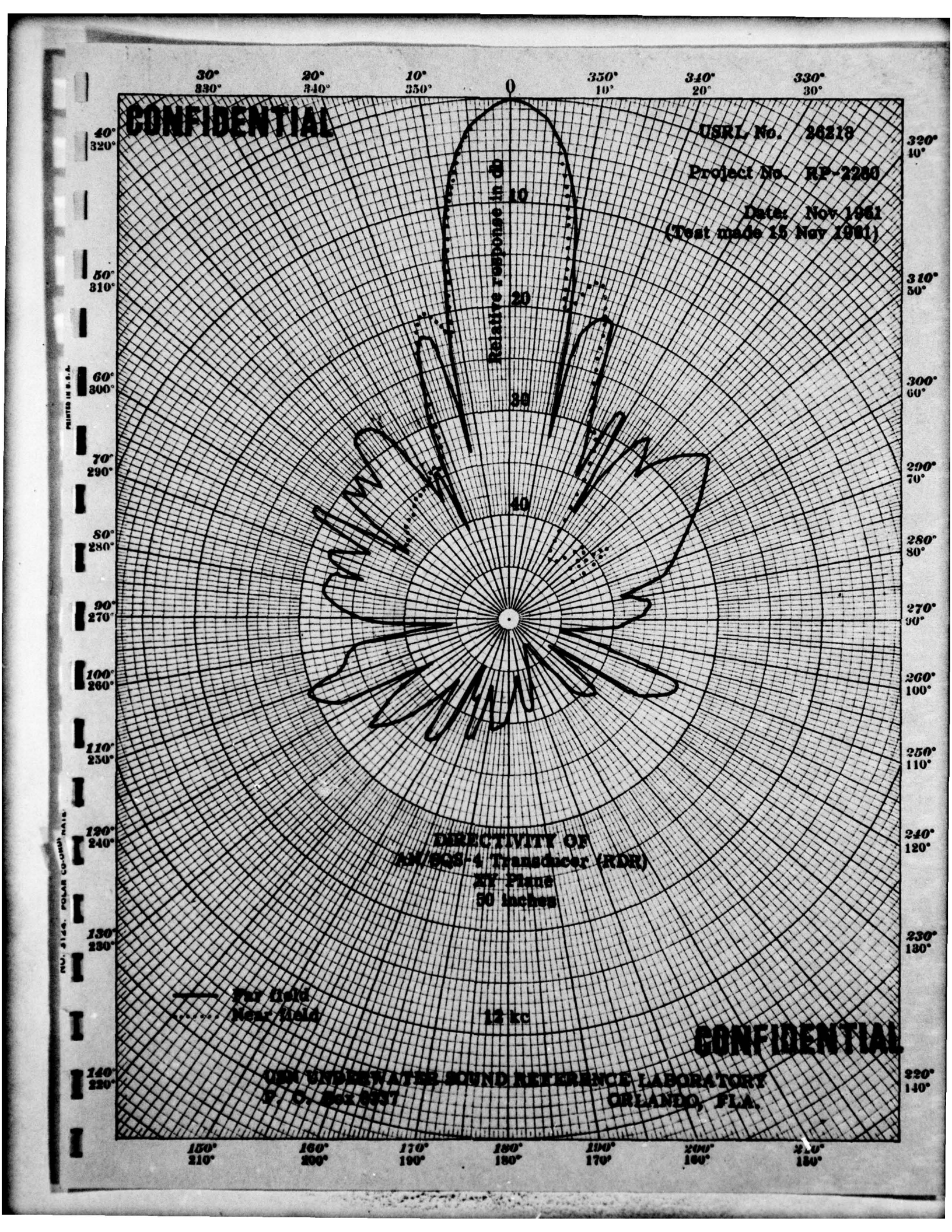
USRL FORM 60A

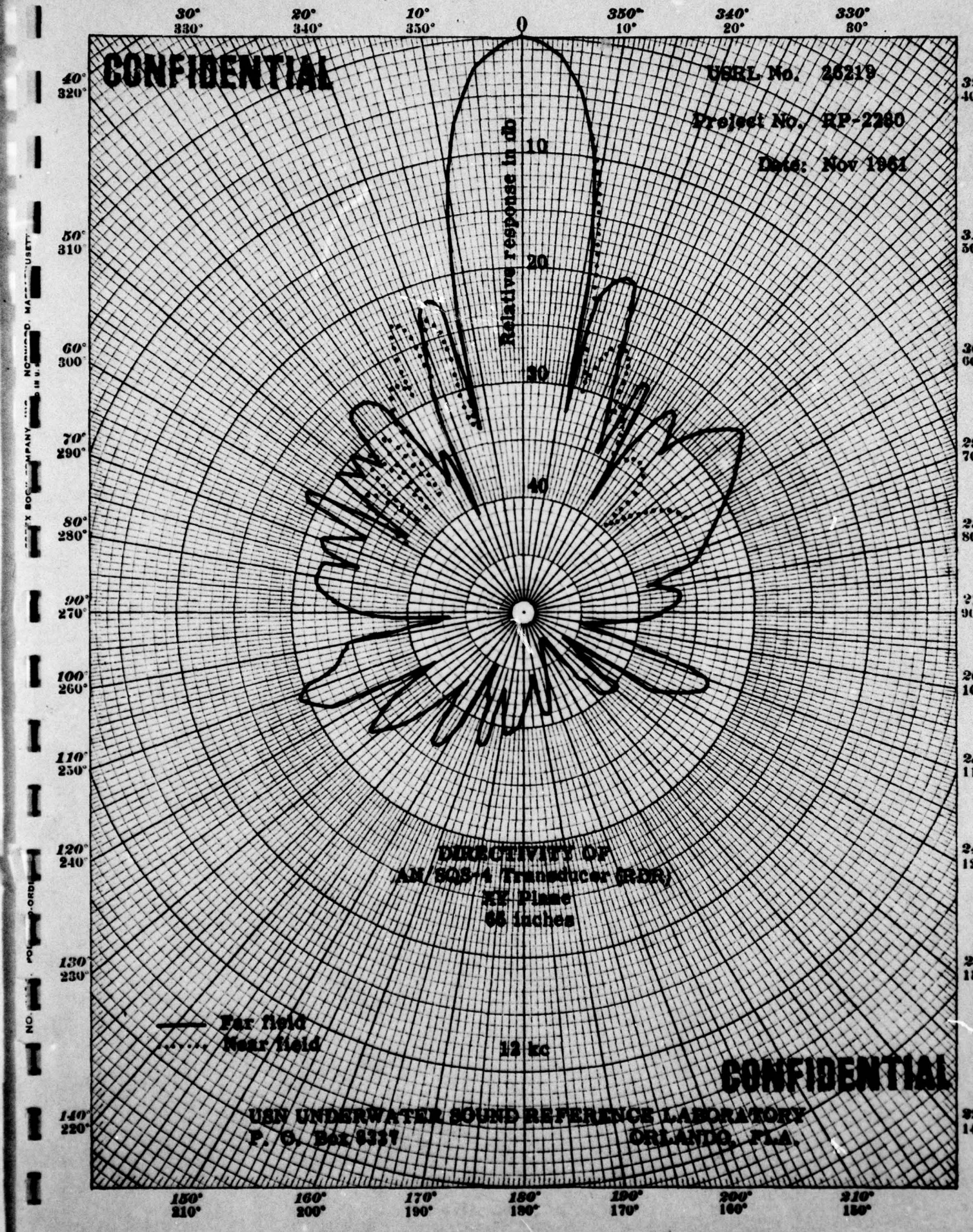
CONFIDENTIAL

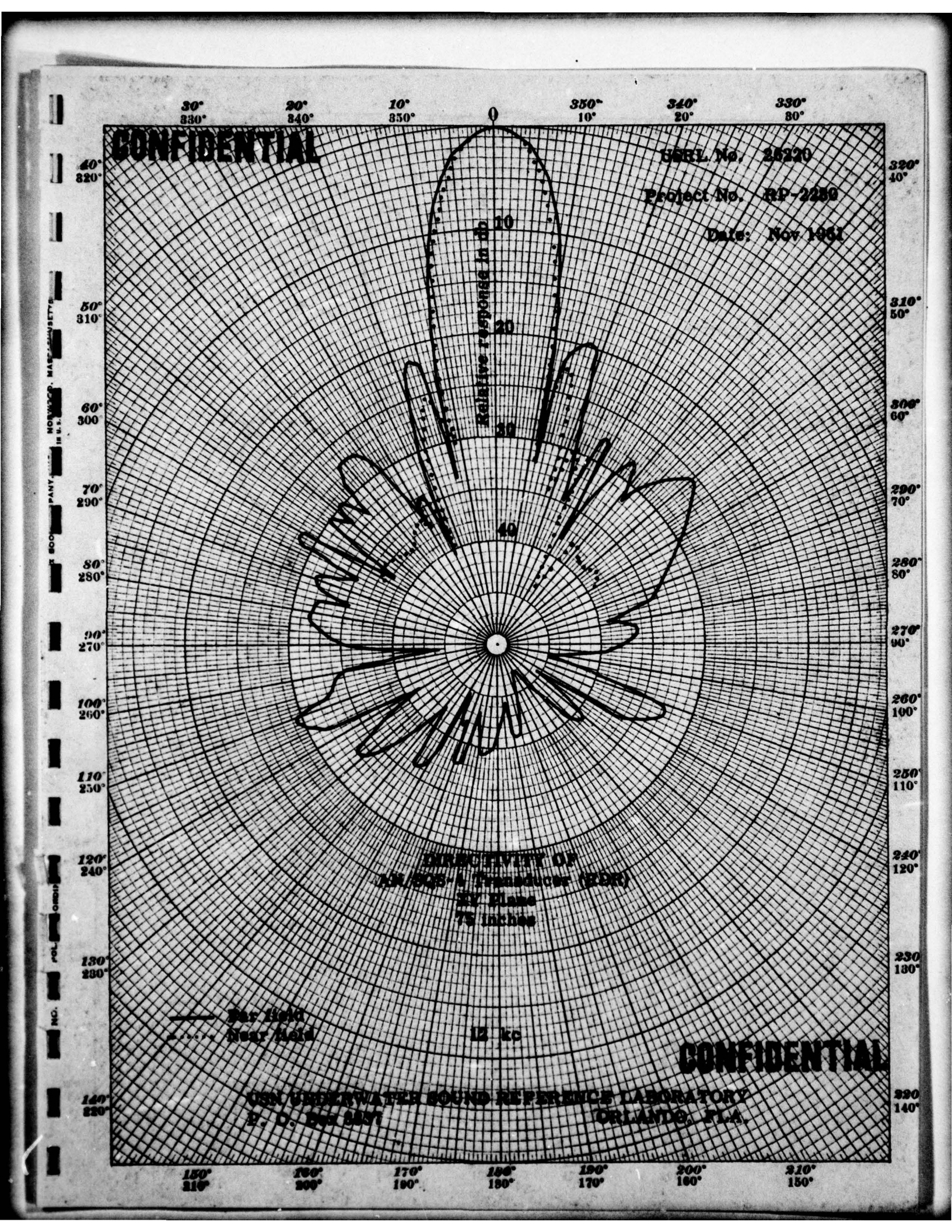

CONFIDENTIAL
USRL NO. 26215
PROJECT NO. RP-2288
DATE: Nov 1961
MEASUREMENTS MADE IN ACCORDANCE WITH AMERICAN STANDARD Z24.24-1957
RELATIVE RESPONSE IN DB
0
10
20
30
40
DIRECTIVITY OF
F31 Line Transducer
XY Plane
12 KC
CONFIDENTIAL
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. BOX 8337
ORLANDO, FLA.
30° 330°
20° 340°
10° 350°
0°
350° 10°
340° 20°
330° 30°
40° 320°
50° 310°
60° 300°
70° 290°
80° 280°
90° 270°
100° 260°
110° 250°
120° 240°
130° 230°
140° 220°
150° 210°
160° 200°
170° 190°
180°
190° 170°
200° 160°
210° 150°

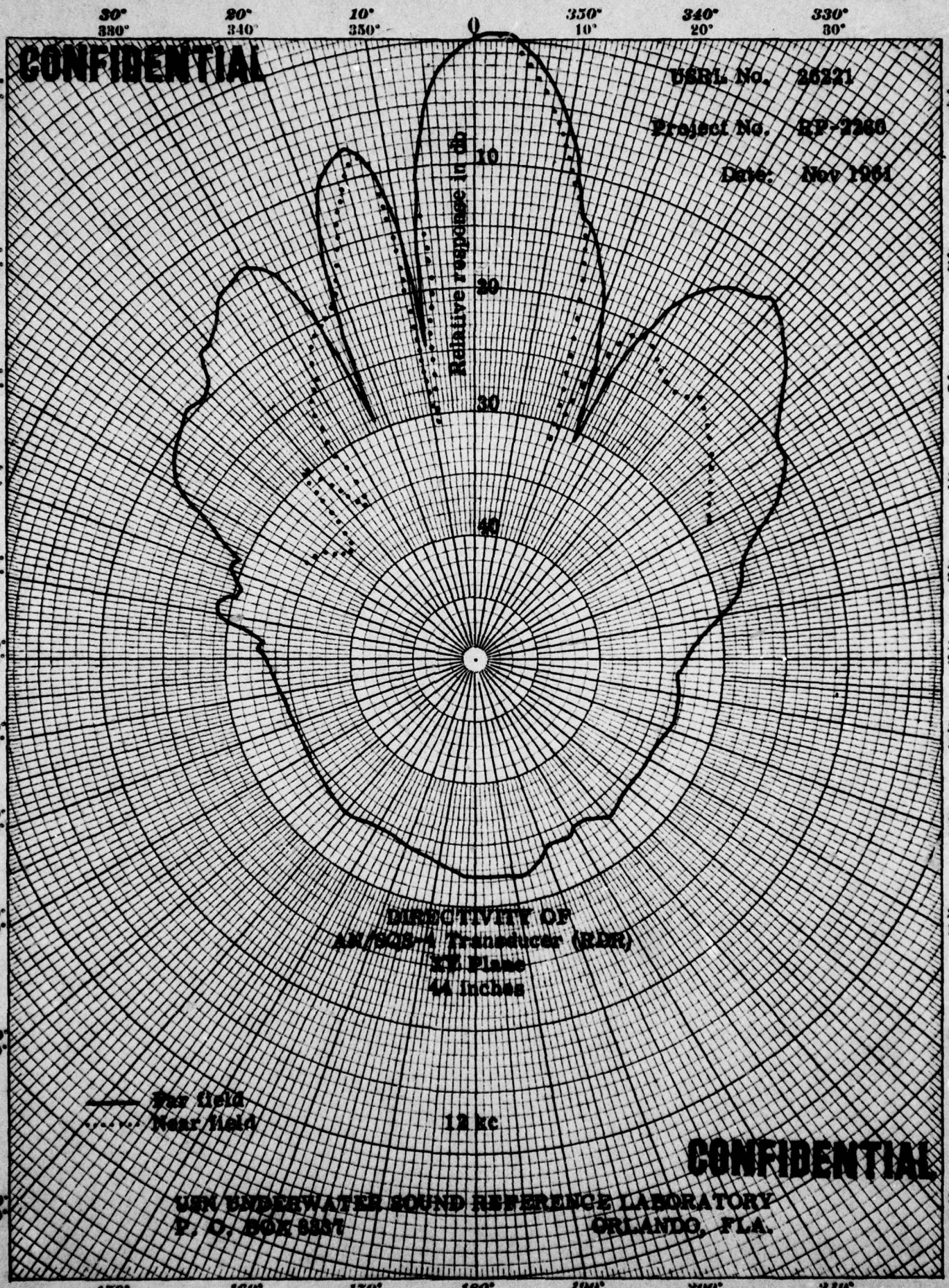

CONFIDENTIAL
USRL No. 25216
Project No. RP-2280
Date: Nov 1961
Relative response in db
10
20
30
40
DIRECTIVITY OF
AN/SQS-4 Transducer (RDR)
XY Plane
36 inches
Far field
Near field
12 kc
CONFIDENTIAL
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 3337
ORLANDO, FLA.
0
10°
20°
30°
340°
350°
330°
320°
310°
300°
290°
280°
270°
260°
250°
240°
230°
220°
210°
200°
190°
180°
170°
160°
150°
140°
130°
120°
110°
100°
90°
80°
70°
60°
50°
40°

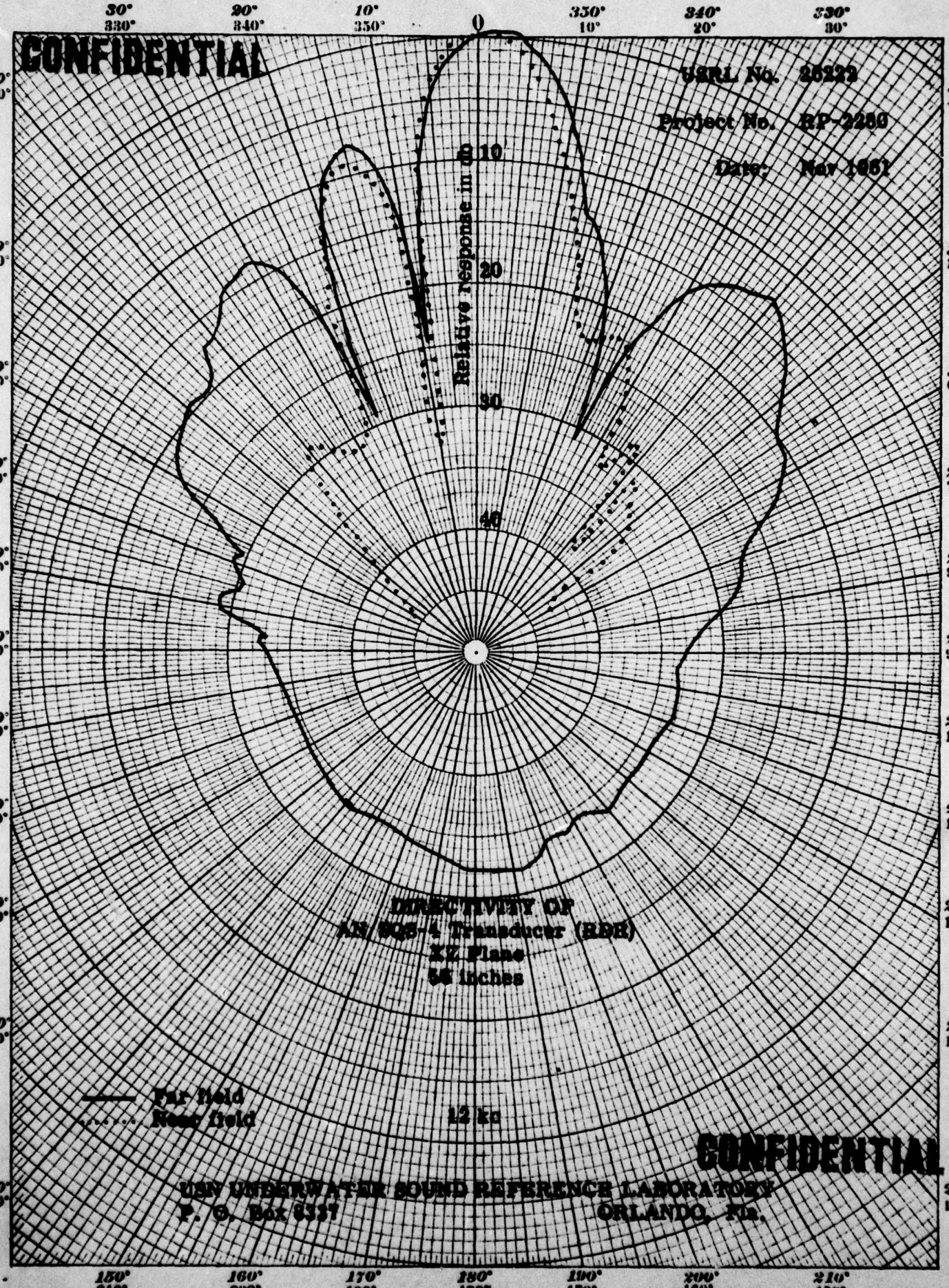

CONFIDENTIAL
USRL No. 26217
Project No. RP-2200
Date: Nov 1961
(Test made 2 Nov 1961)
Relative response in db
10
20
30
40
0
30° 330°
20° 340°
10° 350°
350° 10°
340° 20°
330° 30°
40° 320°
50° 310°
60° 300°
70° 290°
80° 280°
90° 270°
100° 260°
110° 250°
120° 240°
130° 230°
140° 220°
320° 40°
310° 50°
300° 60°
290° 70°
280° 80°
270° 90°
260° 100°
250° 110°
240° 120°
230° 130°
220° 140°
150° 210°
160° 200°
170° 190°
180° 180°
190° 170°
200° 160°
210° 150°
DIRECTIVITY OF
AN/SQS-4 Transducer (RDR)
XY Plane
50 inches
Far field
Near field
12 kc
CONFIDENTIAL
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 8337
ORLANDO, FLA.
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS
NO. 3124 POLAR CO-ORDINATE

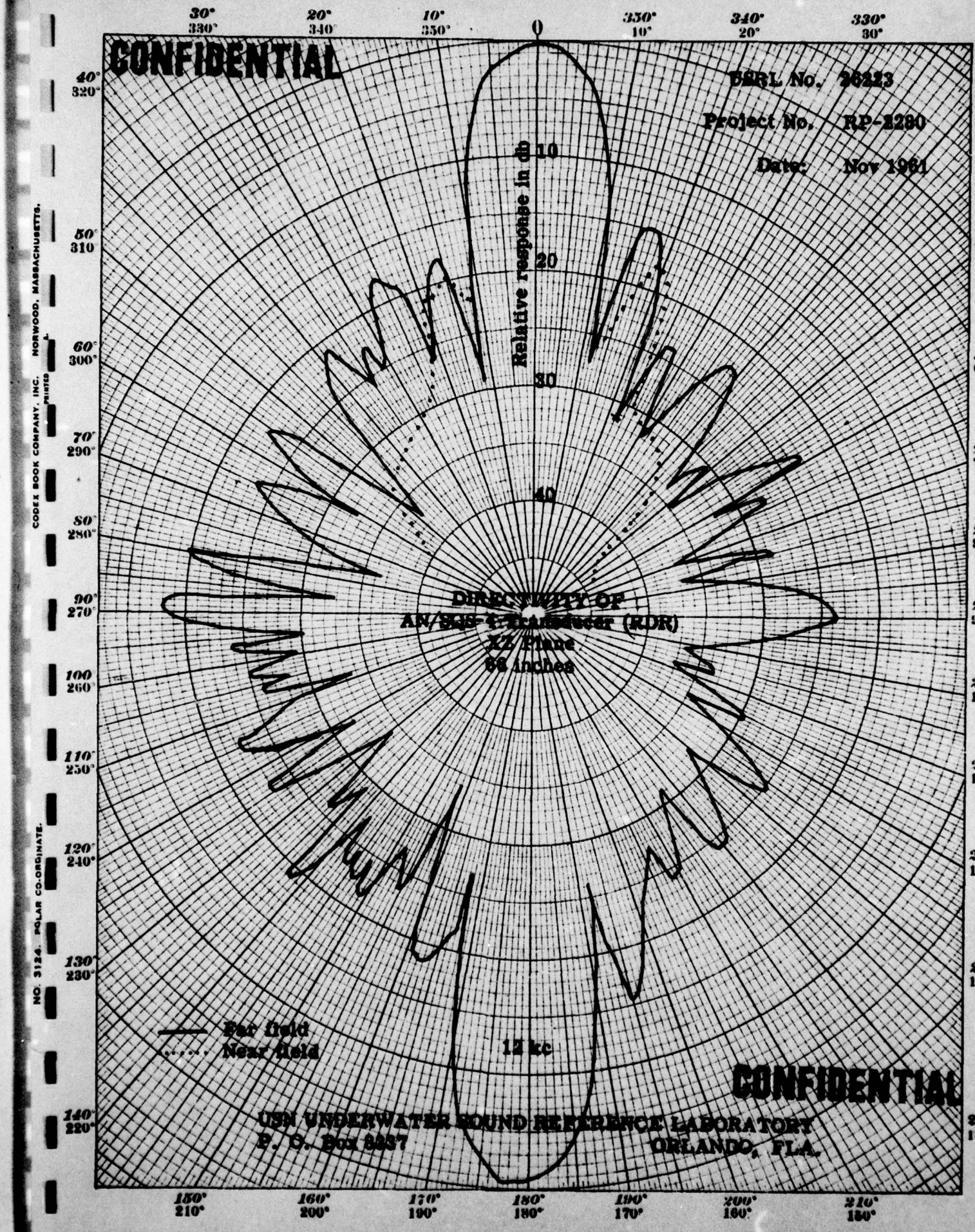

CONFIDENTIAL
USRL No. 26218
Project No. RP-2280
Date: Nov 1961
(Test made 15 Nov 1961)
Relative response in db
10
20
30
40
DIRECTIVITY OF
AN/SQS-4 Transducer (RDR)
XY Plane
30 inches
Far field
Near field
12 kc
CONFIDENTIAL
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 8337
ORLANDO, FLA.
0
30° 330°
20° 340°
10° 350°
350° 10°
340° 20°
330° 30°
40° 320°
50° 310°
60° 300°
70° 290°
80° 280°
90° 270°
100° 260°
110° 250°
120° 240°
130° 230°
140° 220°
150° 210°
160° 200°
170° 190°
180° 180°
190° 170°
200° 160°
210° 150°
220° 140°
230° 130°
240° 120°
250° 110°
260° 100°
270° 90°
280° 80°
290° 70°
300° 60°
310° 50°
320° 40°

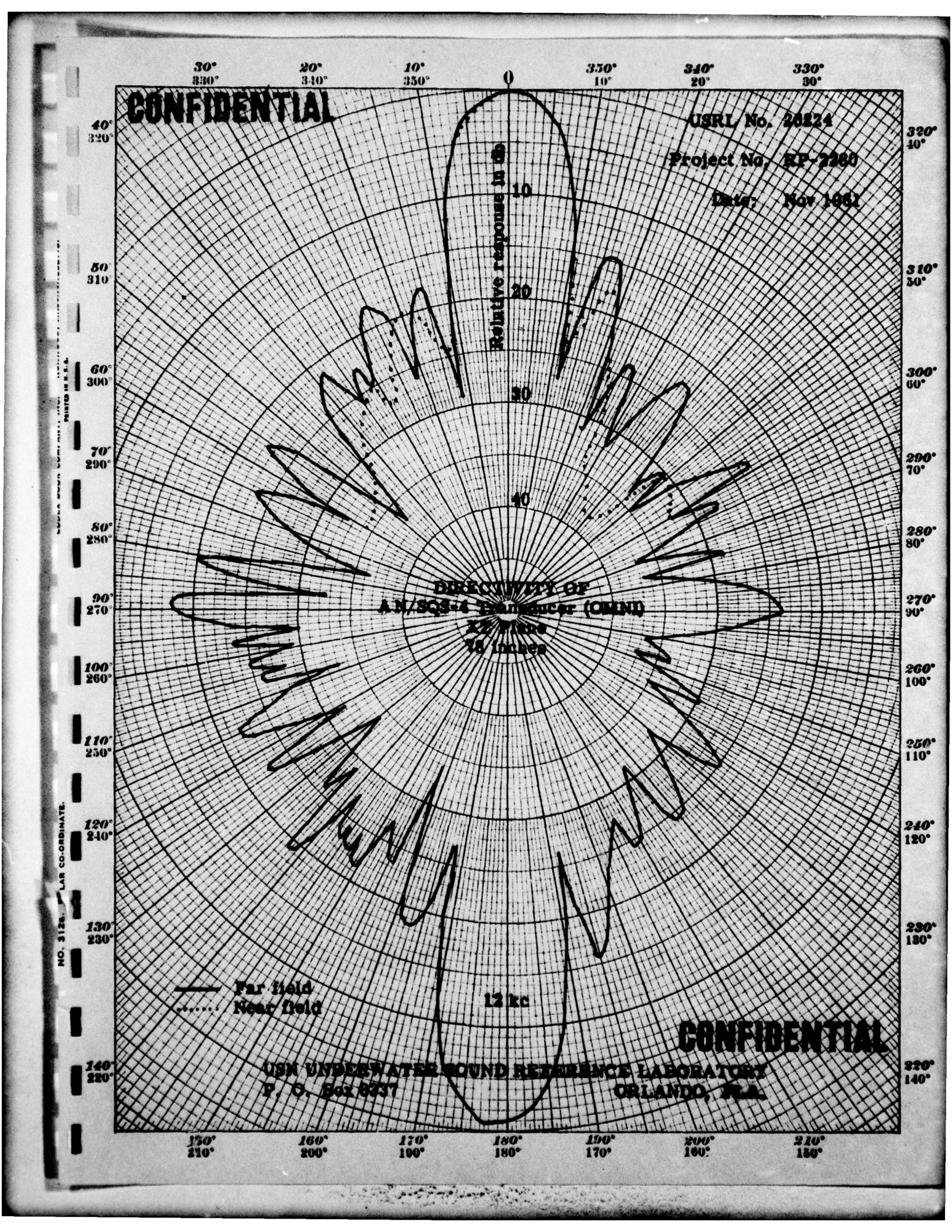

CONFIDENTIAL
USRL No. 26219
Project No. RP-2260
Date: Nov 1961
Relative response in db
0
10
20
30
40
30° 330°
20° 340°
10° 350°
350° 10°
340° 20°
330° 30°
40° 320°
50° 310°
60° 300°
70° 290°
80° 280°
90° 270°
100° 260°
110° 250°
120° 240°
130° 230°
140° 220°
150° 210°
160° 200°
170° 190°
180° 180°
190° 170°
200° 160°
210° 150°
320° 40°
310° 50°
300° 60°
290° 70°
280° 80°
270° 90°
260° 100°
250° 110°
240° 120°
230° 130°
220° 140°
DIRECTIVITY OF
AN/SQS-4 Transducer (RDR)
XY Plane
66 inches
Far field
Near field
12 kc
CONFIDENTIAL
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 8337
ORLANDO, FLA.


CONFIDENTIAL
USRL No. 25220
Project No. RP-2259
Date: Nov 1961
Relative response in db
10
20
30
40
DIRECTIVITY OF
AN/SQS-4 Transducer (EDR)
XY Plane
75 inches
Far Field
Near Field
12 kc
CONFIDENTIAL
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 8337
ORLANDO, FLA.
0
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
240°
250°
260°
270°
280°
290°
300°
310°
320°
330°
340°
350°


CONFIDENTIAL
USRL No. 26221
Project No. RP-2280
Date: Nov 1961
Relative response in db
0
10
20
30
40
DIRECTIVITY OF
AN/SQS-4 Transducer (RDR)
XY Plane
44 Inches
Far field
Near field
12 kc
CONFIDENTIAL
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. BOX 8337
ORLANDO, FLA.
30° 330°
20° 340°
10° 350°
350° 10°
340° 20°
330° 30°
40° 320°
50° 310°
60° 300°
70° 290°
80° 280°
90° 270°
100° 260°
110° 250°
120° 240°
130° 230°
140° 220°
150° 210°
160° 200°
170° 190°
180° 180°
190° 170°
200° 160°
210° 150°
320° 40°
310° 50°
300° 60°
290° 70°
280° 80°
270° 90°
260° 100°
250° 110°
240° 120°
230° 130°
220° 140°
NO. 3124. POLAR CO-ORDINATE.


CONFIDENTIAL
USRL No. 25222
Project No. RP-2280
Date: Nov 1951
Relative response in db
0
10
20
30
40
30° 330°
20° 340°
10° 350°
350° 10°
340° 20°
330° 30°
40° 320°
50° 310°
60° 300°
70° 290°
80° 280°
90° 270°
100° 260°
110° 250°
120° 240°
130° 230°
140° 220°
150° 210°
160° 200°
170° 190°
180°
190° 170°
200° 160°
210° 150°
220° 140°
310° 50°
300° 60°
290° 70°
280° 80°
270° 90°
260° 100°
250° 110°
240° 120°
230° 130°
220° 140°
DIRECTIVITY OF
AN/SQS-4 Transducer (RDH)
XZ Plane
56 inches
Far field
Near field
12 kc
CONFIDENTIAL
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 6337
ORLANDO, Fla.
NO. 3124. POLAR CO-ORDINATE.
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.


CONFIDENTIAL
USRL No. 26223
Project No. RP-2280
Date: Nov 1961
Relative response in db
0
10
20
30
40
DIRECTIVITY OF
AN/SQS-4 Transducer (RDR)
XZ Plane
66 inches
Far field
Near field
12 kc
CONFIDENTIAL
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 3337
ORLANDO, FLA.
30° 330°
20° 340°
10° 350°
0
350° 10°
340° 20°
330° 30°
40° 320°
50° 310°
60° 300°
70° 290°
80° 280°
90° 270°
100° 260°
110° 250°
120° 240°
130° 230°
140° 220°
150° 210°
160° 200°
170° 190°
180°
190° 170°
200° 160°
210° 150°
320° 40°
310° 50°
300° 60°
290° 70°
280° 80°
270° 90°
260° 100°
250° 110°
240° 120°
230° 130°
220° 140°
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS. PRINTED
NO. 3124. POLAR CO-ORDINATE.


CONFIDENTIAL
USRL No. 26224
Project No. RF-2280
Date: Nov 1961
Relative response in db
0
10
20
30
40
30° 330°
20° 340°
10° 350°
350° 10°
340° 20°
330° 30°
40° 320°
50° 310°
60° 300°
70° 290°
80° 280°
90° 270°
100° 260°
110° 250°
120° 240°
130° 230°
140° 220°
320° 40°
310° 50°
300° 60°
290° 70°
280° 80°
270° 90°
260° 100°
250° 110°
240° 120°
230° 130°
220° 140°
150° 210°
160° 200°
170° 190°
180° 180°
190° 170°
200° 160°
210° 150°
DIRECTIVITY OF
AN/SQS-4 Transducer (OMNI)
XZ Plane
18 inches
Far field
Near field
12 kc
CONFIDENTIAL
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 8337
ORLANDO, FLA.

CONFIDENTIAL

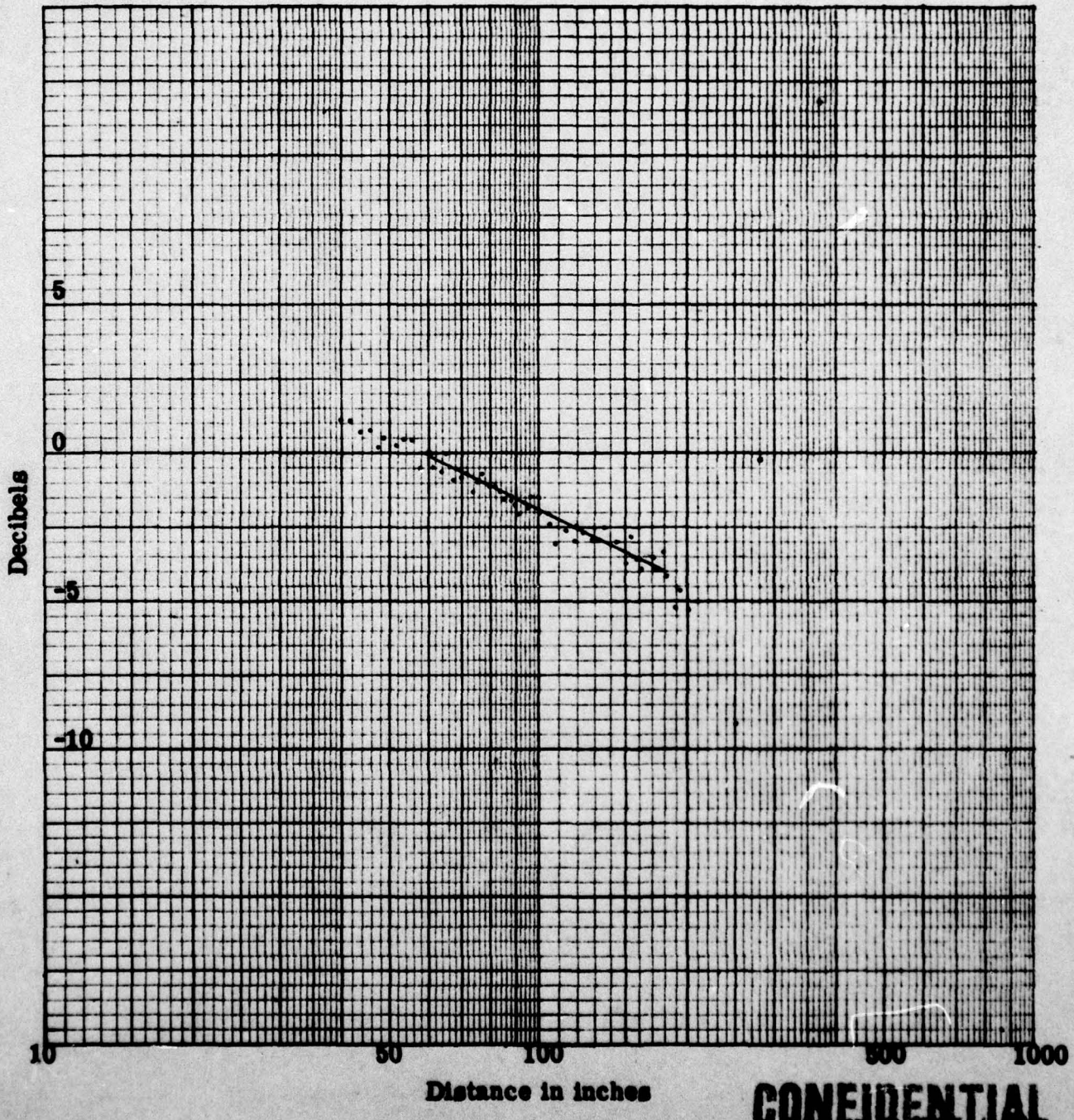
Department of the Navy, Office of Naval Research
UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 8337, Orlando, Florida

USRL No. 26225
Proj. No. RP-2280
Date: Nov 1961

INTEGRATED LEVEL IN NEAR FIELD AS A FUNCTION OF DISTANCE RE 60 INCHES

——— Cylindrical wave normal distance loss (effective near-field region)

Water temp: °C



CONFIDENTIAL

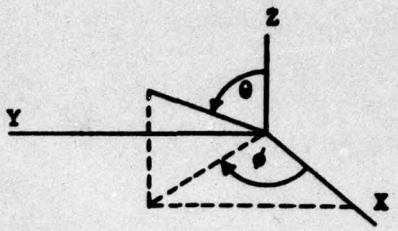
Department of the Navy, Office of Naval Research
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 8337, Orlando, Florida

USRL No. 20113

15 May 1958

COORDINATE SYSTEM FOR TRANSDUCER ORIENTATION

The left-handed coordinate system of the American Standard Procedures for Calibration of Electroacoustic Transducers Particularly Those for Use in Water, Z24.24-1957, is used. The transducer is fixed with respect to the coordinate system and has its acoustic center at the origin. The angle ϕ is equivalent to the azimuth angle in sonar operation.



PLACEMENT OF TRANSDUCER IN COORDINATE SYSTEM

Transducer Type	Transducer Orientation in Coordinate System
Point, or Spherical	Points on surface that coincide with the X and Z axes shall be specified.
Cylindrical, or Line	The axis of the cylinder or line shall coincide with the Z axis. A reference mark in the XZ plane and in the direction of the positive X axis will be specified.
Plane, or Piston	The plane or piston face shall be in the YZ plane with the X axis normal to the face at its acoustic center. A reference mark in the XZ plane and in the direction of the positive Z axis will be specified.
Other Configurations	Orientation shall be shown by sketch or description. This category includes line and piston types of transducers operated in an orientation other than those specified above.

ORIENTATIONS FOR RESPONSE AND DIRECTIVITY MEASUREMENTS

Response. The calibration measurements are made for sound propagated parallel to the positive X axis ($\phi = 0$, $\theta = 90$), unless otherwise specified on the response curve.

Directivity. The plane of the pattern is specified, and the following conventions are observed, if another orientation is not specified on the pattern:

XY Plane: The positive X axis ($\phi = 0$, $\theta = 90$) coincides with the zero-degree direction on the pattern and the positive Y axis ($\phi = 90$, $\theta = 90$) is at 90 degrees measured in a clockwise direction. Rotation is around the Z axis; the positive Z axis is directed upward from the plane of the paper.

XZ Plane: The positive X axis coincides with the zero-degree direction and the positive Z axis ($\theta = 0$) is at 90 degrees measured in a clockwise direction. Rotation is around the Y axis; the negative Y axis is directed upward from the plane of the paper.

YZ Plane: The positive Y axis coincides with the zero-degree direction and the positive Z axis is at 90 degrees measured in a clockwise direction. Rotation is around the X axis; the positive X axis is directed upward from the plane of the paper.

Table 1

COMPARISON OF NEAR-FIELD AND FAR-FIELD DATA

Transducer	Near field distance (inches)	Free-field voltage sensitivity (db re 1 volt per μbar)	
		Near field	Far field
F31 Line		-92.0	-93.5
AN/SQS-4 (RDR) Horizontal Sweep	66	-87.5	
	50	-89.8	
	38	-90.1	-90.6*
	75	-90.0	
	50	-90.0	
AN/SQS-4 (RDR) Vertical Sweep	56	-88.9	-90.6
	44	-89.6	
		Transmitting current response (Pressure in db re 1 μbar per ampere at one meter)	
		Near field	Far field
AN/SQS-4 (OMNI)	60	73.9	
	64	73.8	
	66	74.2	73.7**
	70	73.4	
	74	73.3	
	78	73.4	
	80	73.6	
	78	72.7	
	70	74.5	

*Average of two values: -90.0 and -91.2 db
**Average of three values: 73.9, 73.1, and 74.1 db